

WHAT IS CLAIMED IS:

1. An illumination assembly comprising:  
a substrate comprising an electrically insulative layer on a first side of the substrate and an  
5 electrically conductive layer on a second side of the substrate;  
a plurality of LED dies, each LED die disposed in a via extending through the electrically  
insulative layer on the first side of the substrate to the electrically conductive layer on  
the second side of the substrate, each LED die operatively connected through the via  
to the electrically conductive layer on the second side of the substrate.  
10
2. The illumination assembly of claim 1, wherein the substrate is flexible.
3. The illumination assembly of claim 1, wherein the electrically insulative layer on the  
first side of the substrate comprises a material selected from the group comprising polyimide,  
15 polyester, polyethyleneterephthalate (PET), optically reflective insulative polymers,  
multilayer optical film (MOF), polycarbonate, polysulfone, FR4 epoxy composite, and  
combinations thereof.
4. The illumination assembly of claim 1, wherein the via extending through the  
20 electrically insulative material is chemically etched.
5. The illumination assembly of claim 1, wherein the via extending through the  
electrically insulative material is plasma etched.
- 25 6. The illumination assembly of claim 1, wherein the via extending through the  
electrically insulative material is laser milled.

7. The illumination assembly of claim 1, wherein the electrically conductive layer on the second side of the substrate comprises a material selected from the group comprising copper, nickel, gold, aluminum, tin, lead, or a combination thereof.
- 5 8. The illumination assembly of claim 1, wherein the electrically conductive layer on the second side of the substrate comprises a thermally conductive material.
9. The illumination assembly of claim 1, wherein the electrically conductive layer is patterned to define a plurality of electrically isolated heat spreading elements, each LED die  
10 electrically and thermally coupled to an associated heat spreading element.
10. The illumination assembly of claim 1, further comprising a heat dissipation assembly disposed adjacent the second side of the substrate.
- 15 11. The illumination assembly of claim 10, wherein the heat dissipation assembly is separated from the second side of the substrate by a layer of material that is thermally conductive.
12. The illumination assembly of claim 11, wherein the thermally conductive, material is  
20 an adhesive.
13. The illumination assembly of claim 12, wherein the thermally conductive, adhesive material is a polymer adhesive loaded with boron nitride.
- 25 14. The illumination assembly of claim 11, wherein the thermally conductive, material is non-adhesive.
15. The illumination assembly of claim 14, wherein the thermally conductive, non-adhesive material is a polymer loaded with silver particles.

16. The illumination assembly of claim 10, wherein the heat dissipation assembly comprises a thermally conductive member.

5 17. The illumination assembly of claim 16, wherein the thermally conductive member comprises a material selected from the group comprising metals and polymers.

18. An illumination apparatus comprising:

10 a substrate having an electrically insulative layer on a first surface and an electrically conductive layer on a second surface, a plurality of mounting vias extending through the electrically insulating layer to the electrically conductive layer;  
a plurality of light emitting elements disposed in the plurality of mounting vias, wherein the light emitting elements are operatively connected to the electrically conductive layer through the mounting vias.

15

19. The illumination apparatus of claim 18, wherein the electrically conductive layer is patterned to define a plurality of heat spreading elements

20 20. The illumination apparatus of claim 18, wherein the light emitting elements are LED dies.

21. The illumination apparatus of claim 18, wherein the light emitting elements are selected from the group comprising light emitting diodes, laser diodes and super-radiators.

25 22. The illumination apparatus of claim 18, wherein each of the plurality of mounting vias receives a single light emitting element.

23. The illumination apparatus of claim 18, further comprising a plurality of wirebond vias extending through the electrically insulating layer to the electrically conductive layer,

each wirebond via exposing a corresponding wirebond connection pad of the electrically conductive layer.

24. The illumination apparatus of claim 18, further comprising a thermally conductive  
5 encapsulant contacting the light emitting elements and electrically insulating layer.

25. The illumination apparatus of claim 18, wherein the substrate is flexible.

26. An illumination apparatus comprising:  
10 a layer of electrically insulative material;  
a layer of thermally and electrically conductive material disposed on a bottom surface of the  
layer of insulative material, the conductive material patterned to form a plurality of  
adjacent heat spreading elements;  
a plurality of vias in the insulative material, each via extending through the insulative material  
15 to an associated heat spreading element;  
a plurality of light emitting elements, each light emitting element disposed in one of the  
plurality of vias, each light emitting element thermally and electrically coupled to the  
heat spreading element associated with the via.

20 27. The illumination apparatus of claim 26, wherein each light emitting element is further  
electrically coupled to an electrical connection pad of an adjacent heat spreading element.

28. The illumination apparatus of claim 27, wherein each light emitting element is  
electrically coupled to the electrical connection pad of an adjacent heat spreading element.  
25

29. The illumination apparatus of claim 28, wherein each light emitting element is  
electrically coupled to the electrical connection pad of an adjacent heat spreading element by  
a wirebond.

30. The illumination apparatus of claim 27, wherein each light emitting element is electrically coupled to the electrical connection pad of an adjacent heat spreading element within the via.

5 31. The illumination apparatus of claim 26, wherein the layer of electrically insulative material is flexible.

32. The illumination apparatus of claim 31, wherein the layer of thermally and electrically conductive material is flexible.

10

33. The illumination apparatus of claim 26, further comprising a heat dissipation assembly thermally coupled to the plurality of heat spreading elements.

15 34. The illumination apparatus of claim 33, wherein the plurality of heat spreading elements are spatially isolated by a low modulus material such that the illumination apparatus CTE is dominated by the heat dissipation assembly CTE.

35. A flexible circuit comprising:  
a flexible layer of electrically insulative material;  
20 a flexible layer of electrically conductive material disposed on a first surface of the insulative material, the conductive material patterned to form a plurality of adjacent heat spreading elements, each heat spreading element having a first electrical connection pad and a second electrical connection pad;  
a plurality of mounting vias extending through the insulative material, wherein each mounting  
25 via exposes the first electrical connection pad of an associated heat spreading element.

36. The flexible circuit of claim 35, wherein each mounting via further exposes the second electrical connection pad of an adjacent heat spreading element.

37. The flexible circuit of claim 35, further comprising a plurality of connection vias extending through the insulative material, wherein each connection via exposes the second electrical connection pad of an associated heat spreading element.

5 38. The flexible circuit of claim 35, wherein the insulating material comprises an at least partially reflective multilayer optical film.

39. The flexible circuit of claim 38, wherein the multilayer optical film is shaped into a non-planar light-directing structure.

10